

Shire Integrated Flood Risk Management Volume II - Action Plan

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Plan Design Enable

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1. ACTION PLAN

1.1. Background

Malawi is affected by a number of natural and human-made disasters every year and between 1974 and 2003, hazards cumulatively affected 25 million people (GoM, 2010). Malawi is particularly vulnerable to severe weather events, with 40 weather related disasters in the last 40 years (GoM, 2010). This vulnerability is a result of a combination of physical geo-climatic factors (including erratic rainfall and tectonic activity), environmental factors and socio-economic vulnerability. There is widespread dependence on rain-fed agriculture and use of biomass for household energy. In addition, Malawi has a narrow economic base and extensive rural poverty (GoM, 2011a). The intensity, frequency and number of people affected by such disasters appears to be increasing, a trend attributed to climate change, population growth, urbanisation and environmental degradation.

According to the Terms of Reference (ToR) 23 flooding events have occurred in Malawi in 29 years (1979 – 2008) which cumulatively affected 1.9 million people. Table 1-1 is a chronology of past flood events in tabular form while Figure 1-1 is a map of flood locations, based on the DNRDM list 'National Profile of Disasters in Malawi'.

The Shire River and its tributaries are a major source of flooding, with the highest flooding frequency in the country occurring in the Lower Shire valley. The Shire River is economically and environmentally very important, with hydroelectric schemes generating 98% of Malawi's electricity, extensive fisheries and wildlife conservation areas and provision of freshwater irrigation to cash crop plantations, industrial and domestic uses.

Approximately half a million people live in the Lower Shire valley and are regularly affected by flooding and water pollution. The highest risk areas in the Shire are Chikwawa and Nsanje districts, which are located in the lower section of the basin. In Nsanje 70% of the people are affected by the floods while in Chikwawa 40% of the people are affected. In Mangochi district just downstream of the Lake outflow in the upper section of the basin, flooding is caused when lake levels are high. Flooding has resulted in higher poverty and vulnerability levels in high risk districts. Since the 1970s, flooding in the basin has occurred once in every 2 - 5 years. The Shire River basin is important to the development of agricultural production and other economic activity given its geographic and climatic conditions and is therefore of national importance. If vulnerabilities and hazards could be addressed, intensified agricultural production, better transport linkages and secured homesteads can make the valley an economic hub of Malawi and the region, and lift many people out of poverty. In the short and medium term the focus should be on building interventions on a better understanding of the risk profiles, and mitigating immediate loss that occur almost annually.

A number of efforts are being implemented by Malawi government and other stakeholders to reduce the risks and mitigate the impacts of floods in the Lower Shire valley. However the efforts are not harmonized and are being implemented in isolation by different agencies in the Shire basin, yielding little visible impact overall. Furthermore, community participation in catchment protection and management is limited and enforcement of catchment protection and institutional management approaches are weak in the region and the country as a whole.

The Integrated Flood Risk Management Plan for the Shire Basin is part of Component III of the umbrella Shire River Basin Management Project (SRBMP) (World Bank), which will address the interlinked challenges of poverty and a deteriorating natural resource base in the Shire River Basin, to reduce the process of environmental degradation and improve the productive potential of natural resources. The SRBMP project will promote integrated climate resilient investment planning in the basin, including institutional capacity building to plan and monitor changes in land use patterns at a basin level. Project activities will support strategic planning of large-scale infrastructure investments and adoption of sustainable land, forest and water management practices to reduce land degradation in production landscapes and improve the productivity and incomes of smallholder farmers. Project investments will be designed to support the Government of Malawi's economic growth and development plans in the basin. The Project is organized in three components: (i) Institutional Capacity Strengthening for Basin Planning, Management and Development; (ii) Livelihoods-Based Watershed Management; and, (iii) Infrastructure Development to Mitigate the Impacts of Floods and Droughts to Support Sustainable Economic Growth and Food Security.

The main aim of Shire Integrated Flood Risk Management Project (Shire IFRMP) was to develop a 5-year Action Plan for strategic flood risk management of the Shire Basin, which will provide the Government of Malawi with an Integrated Implementation Plan, based on sound and detailed diagnostics, and essential

guidelines to address the flood hazard situation in the Shire basin in an organized manner with ample attention to all components in an integrated way. This document is Volume II of the final report. Volume I and earlier reports (Inception and Interim) contains details about the data used, the methodologies and the outcomes of a 12 month study of the flood risk in the Shire basin, while this document, Volume II details the Action Plan that was produced.

Table 1-1: Reported flooding based on DNRDM's National Profile of Disasters spreadsheet

Year	Location
1970	Chikwawa, Nsanje
1973	Chikwawa
1975	Machinga, Mangochi, Mulanje, Nsanje, Zomba
1982	Chikwawa, Mwanza
1986	Chikwawa
1989	Balaka, Chikwawa, Chiradzulu, Machinga, Mangochi, Mulanje, Mulanje, Nsanje, Nwanza, Salima, Zomba
1991	Chiringa, Mulanje, Phalombe
1995	Chikwawa, Karonga, Nkhatabay, Nsanje
1996	Nsanje
1997	Chikwawa, Nsanje, Karonga, Nkhotakota, Phalombe,
1999	Chikwawa, Nsanje
2000	Chikwawa, Karonga, Nkhotakota, Nsanje
2001	Blantyre, Chikwawa, Dedza, Karonga, Kasungu, Machinga, Mangochi, Mchinji, Mwanza, Nkhotakota, Nsanje, Phalombe, Salima, Thyolo, Zomba
2002	Balaka, Blantyre, Chikwawa, Dedza, Dowa, Karonga, Kasungu, Kasungu, Machinga, Mangochi, Nkhotakota, Nsanje, Ntcheu, Phalombe, Rumphu, Salima, Zomba
2003	Balaka, Bwanje, Chikwawa, Dedza, Dowa, Karonga, Lilongwe, Machinga, Mchenga, Mwanza, Mzuzu, Nsanje, Ntcheu, Nyungwe-Wovwe, Phalombe, Rumphu, Salima
2004	Chikwawa, Nsanje
2005	Chikwawa, Machinga, Mangochi, Mzimba, Nkhatabay, Nsanje, Ntcheu
2006	Chikwawa, Malindi, Salima
2007	Balaka, Blantyre, Chikwawa, Chiradzulu, Chitipa, Galonga, Karonga, Lilongwe, Lundu2, Machinga, Mchinii, Mtemangawa, Mzimba, Nkhatabay, Nsanje, Ntcheu, Phalombe

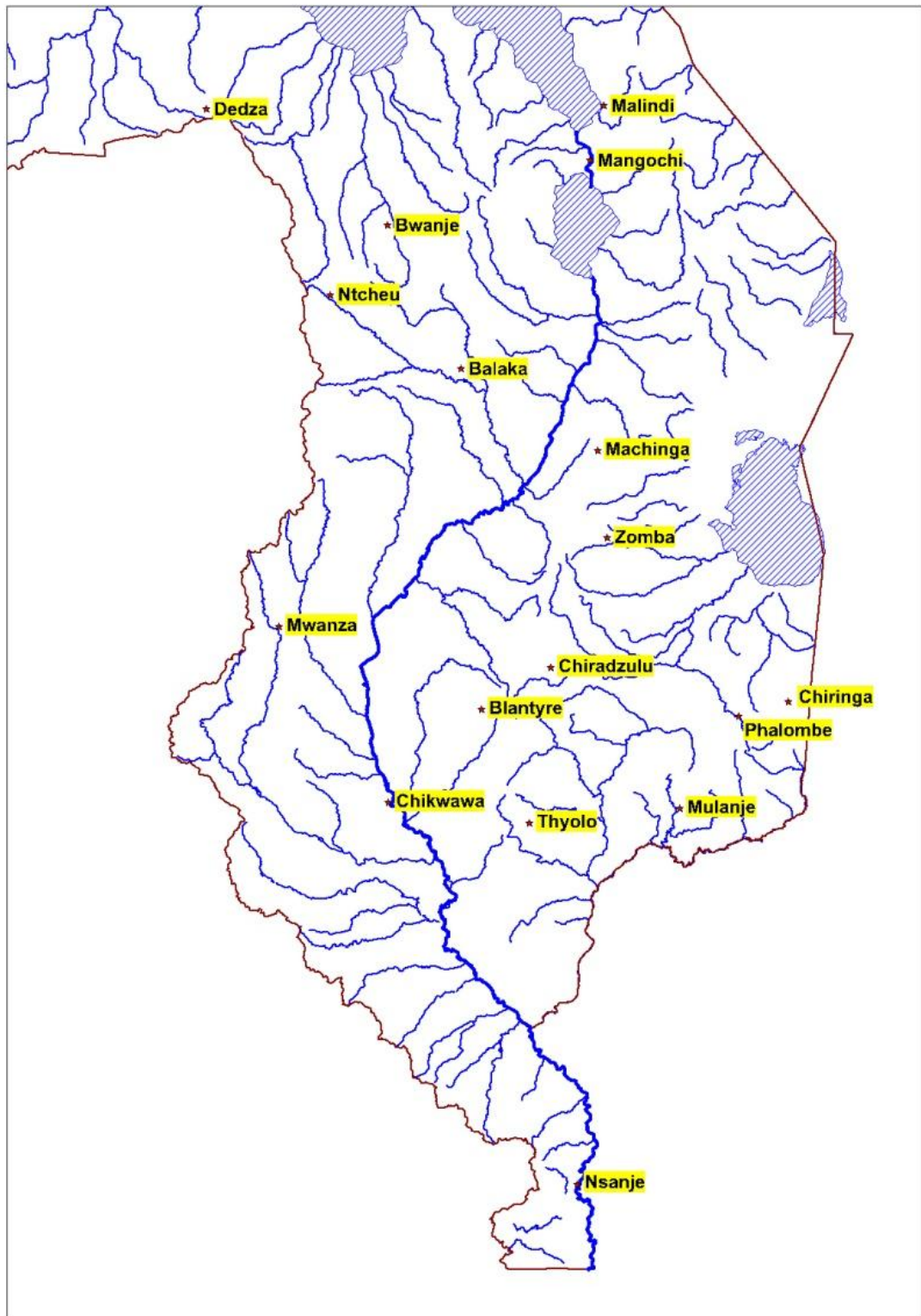


Figure 1-1: Location of areas where flooding has been reported

1.2. Guiding Principles

There are a number of principles that underpin this action plan and which have guided the preparation of the plan. They are as follows:

1. Flooding is a development issue/natural processes. The plan therefore looks to identify where human development and activities intersect with high flood risk areas, and to implement measures that protect populations from flooding (structural and non-structural measures), moves populations and activities away from harm (establishing flood zoning), and prepares the GoM and the affected people in the Shire basin to effectively respond to flooding in a strategic manner, as well as during flood events (flood forecasting and early warning)
2. Flood management requires a whole of government/country approach, involving partnerships between and among government agencies, donors, communities/land owners and private sector players. The Action plan provides for improved institutional structure and increased skills to equip all stakeholders to contribute to a holistic approach to flood risk management
3. Adopting a pragmatic and integrated approach including flood management, risk reduction, preparedness, response and recovery.

1.3. Action Plan Goals

The action plan has four high level goals which are:

1. Enabling flood risk management in Malawi through the provision of flood risk assessment tools
2. Enhancing flood preparedness and response through the development of a flood forecasting and early warning system for the Shire basin
3. Building capacity for flood risk management in Malawi through Institutional strengthening
4. Reducing flood risk and building resilience in Malawi

1.4. Five Year Action Plan

The 5-year Action plan is comprised of a prioritised list of costed options and activities which have been grouped under the following themes which map directly to the 4 high level goals:

1. Hydrodynamic Modelling Framework
2. Flood Forecasting and Early Warning System
3. Institutional Development and Capacity Building
4. Structural Interventions

These themes are further broken down into a number of activities which have been evaluated through technical, economic and environmental assessments and costs estimates to enable prioritisation within the Action Plan (see Volume I – Final Report – for detail).

In addition to this document, the action plan is provided as an excel workbook comprising worksheets (Annex A of this Volume) as follows:

1. A costed and prioritised list of options and activities
2. An activities programme based on packaging of the options
3. An Action Plan risk log – to be developed during the implementation, for detailing and managing the risks associated with each main theme in terms of barriers to achieving the desired outcomes and

the consequence or impact on the overall action plan should the risk be realised. We have also provided a methodology for assigning overall risk probability and

4. A detailed description of each option including the assumptions used in deriving costs

The proposed Action Plan is shown in Table 1-4 to Table 1-7 below. These tables show interventions respectively for HD Modelling, Flood Forecasting and Early Warning, Institutional Development and Capacity Building, and Structural Interventions. For each intervention, indicative expenditure is shown for each of the five years and an estimated total cost.

1.4.1. Hydrodynamic Modelling Framework

As part of the project a hydrodynamic modelling framework was developed and is a key deliverable of the project which will enable the Government of Malawi to use it for the following:

1. generate flood inundation maps for use in spatial planning to zone development away from high flood risk areas
2. assist in the design of flood mitigation measures including the sizing of structures such as culverts, bridges, levee heights
3. assess the technical feasibility and impact of mitigation measures both structural and non-structural
4. form the basis of emergency planning and response
5. form the basis of a flood forecasting model to be developed in the future

As such the modelling framework meets the following objectives:

1. It is a hydrodynamic model of the catchment from Liwonde barrage to the Zambezi confluence, capable of predicting inundation of the floodplain for extreme fluvial flooding.
2. It is capable of simulating and mapping floodplain inundation for a range of design flood scenarios
3. It can be used to assess the effectiveness of potential interventions to mitigate flood impact
4. It is capable of being updated in the future to improve its accuracy and reliability once better data becomes available for the catchment.

The modelling frame was developed with the use of the most appropriate available data during the project. As detailed in the main final report, there are a number of limitations with the datasets and hence, the key focus of the Action plan activities under the modelling theme is to update the modelling framework that has been developed with better, more accurate data and to increase data coverage. Hence the following have been identified as essential sub-activities within this theme.

1. Topographic surveys
2. Model framework further development and update
3. Development of data sharing and data management procedures and technologies
4. Additional modelling studies to be undertaken including geomorphological modelling
5. Modelling studies to be undertaken in support of the feasibility studies that will be needed for designing flood management intervention measures.

The activities listed under the modelling theme are needed to provide better and more accurate representation of the Shire basin characteristics and to enable better informed and more robust technical assessments to be made during the design of solutions and for the long-term strategic flood risk management of the catchment.

1.4.2. Flood forecasting and Early Warning System – FFEWS

The main aim of the 'Flood Forecasting & Early Warning' component (or FFEWS) was to develop a Terms of Reference (ToR) for the detailed design and implementation of an improved flood warning service in the Shire Basin, with a focus on the Lower Shire and Lower Ruo areas. That is to: *".....develop a ToR for consultancy services (on detailed design, software development and testing, installation, and facilitation of roll-out of the flood forecasting and early warning system, and institutional capacity building on the same), as well as specified list of hardware requirements (to be finalized by the subsequent consultancy)." The project specification also noted that "The present forecasting system, based on a simple procedure of manually reading rainfall and water levels, will need to be professionalized".*

In developing the ToR, a range of options was considered, from procedural improvements to the existing manually-based approaches to a basin-wide decision support system¹ covering multiple applications (water supply, irrigation, hydropower, flood warning etc.). The following general principles were established to guide development of the ToR:

- The focus should be on building technical and institutional capacity at all levels (national, district, community) introducing new technology as skills and resources permit
- The requirement is not for a single flood forecasting and early warning system, but rather for an integrated set of community-based, district and national level approaches – both manually operated and automated - with well-defined procedures for exchanging information and clearly defined roles and responsibilities
- The present manually-based approach to data transmission needs to be improved to support flood forecasting applications. An improved data transmission approach needs to enable real-time data to be acquired from gauges, and shared between the key government departments (DCCMS, MWDI and DNRDM in real time, and more widely in the basin (data sharing locally between communities to enhance regional flood warning). In addition, upgrading of manual observations to telemetered real time observations will reduce the risks to observers during flood events (flood waters, night-time operation, snakes, crocodiles etc.). A centralised telemetry system on the scale of the UNDP/WMO system from the 1990s is desirable
- There are many planned and ongoing initiatives which provide opportunities to accelerate development of an improved flood warning service but which also present risks of duplication of effort
- The fast response of tributaries of the Shire (including the Ruo) means that an around-the-clock (24/7) service will need to be operated during flood events, involving all key participants in the flood warning process

The Terms of Reference developed in this project for the detailed design of the FFEWS therefore attempt to take account of these factors, and the following title is proposed for the detailed design study to reflect both the change in emphasis away from provision of a single system, and that the study should build on existing systems (rather than starting anew):

"Consultancy services for the detailed design and implementation of improvements to the flood warning and forecasting service in the Shire Basin"

In particular, the focus is on provision of an improved service to communities, with strong community involvement, defined standards of service, up-to-date and tested flood response plans, and routine performance monitoring and post-event reporting.

The following table summarises the tasks that will be undertaken in the development of the FFEWS. These tasks are essential for implementing the proposed FFEWS and are therefore essential components of the Action plan.

¹ Since the present project started, a proposal for a basin planning decision support system has now been included in Component A of the Shire RBMP, and would include refined versions of the flood forecasting tools developed as part of 5-year project described in the ToR

Table 1-2: Summary of Activities under the FFEWS theme

Task	Title	Summary
1	Inception Phase	Review of available documentation from past and ongoing studies; data collection and analysis; analysis of potential overlaps/duplication with other relevant projects; structured consultations with key stakeholders; field visits to selected communities, districts, gauges; develop work plan, risk matrix and programme for main phase
2	Monitoring - river and rainfall real-time data acquisition	Assessment of gauges to be improved or provided (in accordance with these ToR); identification of equipment required; preparation of tender documentation and advice on procedures for procurement; assistance with tender review and contract award; supervision of implementation; preparation of guidance documents and procedures; training and capacity building
3	Data interpretation and procedures for issue of flood warnings	Assessment of requirements (in accordance with these ToR); recommendations for implementation; preparation of guideline documents and procedures
4	Dissemination of warnings to districts and communities	Assessment of overall requirements (in accordance with these ToR); Identification of equipment required; preparation of tender documentation and advice on procedures for procurement; assistance with tender review and contract award; supervision of implementation; preparation of guidance documents and procedures; training and capacity building
5	Establishment of Community-based flood warning schemes	Generic: Identification of schemes; community engagement; training and capacity building. preparation of guidance documents and procedures Schemes: preparation of tender documentation and advice on procedures for procurement; assistance with tender review and contract award; supervision of implementation
6	Establishment of Lower Ruo/Lower Shire flood warning scheme	Design and implementation; preparation of guidance documents and procedures; community engagement; training and capacity building
7	Development of Flood Forecasting Capability	Design and implementation; preparation of guidance documents and procedures; training and capacity building

1.4.3. Institutional Development and Capacity Building

An Institutional and Capacity Development Plan has been developed as an integral component of the Integrated Flood Risk Management Plan. Its key components are summarised below.

Table 1-3: Summary of activities under the Institutional Development and Capacity Building theme

Stakeholder	Interventions
MWDI	<p>Training in installation and maintenance of new river gauges.</p> <p>Training for staff to update, operate and maintain the hydraulic model</p> <p>Financial support to appoint programme management including training support package.</p> <p>Financial support to develop construction guidelines and provide training in their use.</p>
MET services	<p>Training in installation and maintenance of new rain gauges.</p> <p>Financial support to enable staff to digitise new and historic data.</p> <p>Support to improve weather forecasting</p> <p>Support to initiate data exchange with Mozambique</p>
DNRDM	<p>Provision of vehicles and communications equipment</p> <p>Provision of financial support to enable DNRDM to deliver its training responsibilities</p> <p>Support to enable DNRDM to improve and test standard operational procedures and internal management tasks.</p>

The Institutional Capacity Development Plan was designed around the key changes which a new FFEWS and HD modelling framework would introduce together with the broader responsibilities of DNRDM with regard to flood preparedness, response and recovery. The plan ensures that critical capacity development and training is supported to enable the key stakeholders to fulfil their roles under a new FFEWS and HD model system and maintain the relevant systems upon which the FFEWS will depend. The plan recognised the emergence of a Shire River Basin Management Organisation and envisages that in five years' time – as the Action Plan is fulfilled – much of the institutional framework for a FFEWS could then be devolved to the SRBMO.

1.4.4. Structural Interventions

Structural options for mitigation flood risk were considered and developed in outline for further development (i.e. feasibility and detailed design) as part of the action plan. Features of the proposed structural intervention options for inclusion in the Action Plan are summarised below.

1.4.4.1. Flood Defence Embankments

Flood defence embankments have been investigated for critical villages in Chikwawa and Nsanje districts. Optimisation of embankment types for these villages has been achieved by means of modelling and economic analysis although the inaccuracy of the topographic data on which these analyses are based has meant that embankment lengths could not be accurately determined. Provision is needed to cater for possible increases in embankment length when designs are finalised.

Also, the lack of accurate survey data has meant that assessment of flood defence embankments in Mulanje, Mwanza, Thyolo and Blantyre districts has not been possible and provision will be needed for the assessment, design and implementation of embankments in these districts when improved data is available.

1.4.4.2. Food Stores

Construction of food stores in critical villages in Chikwawa and Nsanje districts has been included - based on standard designs - and provision will be made for the construction of similar stores in the other districts.

1.4.4.3. Catchment Improvement

From the investigation of the Mwanza and Ruo tributaries only catchment improvements in the upper Mwanza were shown to be viable. Provision has been made for further assessment. This will include assessment of other catchments and of the relative merits of complete re-forestation or scattered vegetative cover.

1.4.4.4. Flood Storage

The investigation of this option concluded that extremely large volumes of water would need to be stored off-channel to make any difference to flood depths downstream. Therefore, although the economic assessment of this option is incomplete, viability remains unproven. Accordingly, this option has not been included in the Action Plan.

1.4.4.5. Dredging

The action plan includes a budget for the annual maintenance of waterways at culverts and bridges. Given the high rates of sedimentation in the catchment annual dredging will be necessary to maintain the standard of protection provided by new flood defences, and to ensure that flow conveyance capacity at structures such as culverts and bridges is maintained.

1.4.4.6. Flood Proofing of Buildings

The action plan will include a study of the benefits of flood proofing of existing buildings to act as flood shelters.

Table 1-4: Action Plan – Hydrodynamic Modelling Framework

High level Goals	Theme	Intervention	Detail of Action	Funding	Responsible Agency and Implementing Partners	Evaluation/Indicators of success	Y1 (US\$)	Y2 (US\$)	Y3 (US\$)	Y4 (US\$)	Y5 (US\$)	Total (US\$)
Enabling Flood Risk Management in Malawi through provision of flood risk assessment tools	1.Hydrodynamic Modelling Framework											
Rank	1.1 Topo Surveys											
7	1.1.1	Topo Surveys at Ruw/Shire confluence	10-15km immediately downstream to fully characterise the confluence flow (if this is available from the JICA report then it isn't necessary to do it)	Action Plan	MWDI with contractor partners	Critical reaches of the Shire river and it's tributaries fully characterised through topographic surveys within acceptable QA framework	160000					160000
4	1.1.2	Topo Surveys at critical tributaries		Action Plan/SRBMP-I			750000					750000
7	1.1.3	Topo Surveys at critical reaches of Shire	Critical reaches on the Shire identified as needing topo surveys. Likely to be reaches upstream of Chikwawa	Action Plan/SRBMP-I			750000					750000
10	1.1.4	Topo surveys of gauge locations	Initial Topo surveys of gauges locations for new and existing gauges	Action Plan/SRBMP-I			300000					300000
	1.1.5	Systematic Topo Surveys at Gauges, structures and key locations	Annual/biannual topo Surveys at gauges, structures and key locations	Action Plan/SRBMP-I				80000	80000	80000	80000	320000
11	1.1.6	Additional Surveys for lower priority vulnerable tribs	Allowance for surveys later in Action Plan	Action Plan						100000	100000	200000
	1.2 Model Establishment, development and Update											
2	1.2.1	Modelling software purchase	Initial Purchase of modelling licences	Action Plan/SRBMP-I	MWDI with consultant partners	Modelling framework fully installed and functioning within the identified organisations within the first year of the Action plan. Model developments achieved within year 1 and appropriate maintenance throughout the 5-year plan	250000					250000
2	1.2.2	Modelling software maintenance	Maintenance essential to ensure software provider support	Action Plan/SRBMP-I			9500	10000	10500	11000	12000	53000
2	1.2.3	Modelling hardware purchase	Dedicated high spec computers for developing and running the model	Action Plan/SRBMP-I			5000			7000		12000
5	1.2.4	Extend model to include tributaries		Action Plan/SRBMP-I			100000					100000
1	1.2.5	Updating the model for sub-daily data, LiDAR data and new topo surveys	Essential when LiDAR data becomes available. This will be essentially a re-build within the framework provided	Action Plan/GFDRR DRM program			100000					100000
6	1.2.6	Update economics assessment of options using updated model	Essential following update of model with LiDAR data.	Action Plan/GFDRR DRM program			50000					50000
	1.3 Data Sharing and management											
1	1.3.1	Digitise existing paper copies of sub-daily rainfall and flow data	Needed for model calibration, design modelling and establishment of catchment response, and for FFEWS	Action Plan/SRBMP-I	MWDI with DCCMS and DNRDM as partners	Historical data digitised and managed with central hydrometric database. Improved data collection and archiving procedures. Data sharing protocols and systems in place	10000					10000
8	1.3.2	Improve the collection and archiving of sub-daily rainfall and flow data in the future	Establish data collection and archiving procedure. Possible review of database systems between Met and MWDI	Action Plan/ ECRP (DFID, Ireland & Norway)SRBMP-I			50000	36000	36000	36000	36000	194000
8	1.3.3	Improve data sharing between Met, MWDI and DNRDM	Establish data sharing procedures and protocols.	Action plan/GFDRR DRM Program/UNDP/SRBMP-I			50000	10000	10000	10000	10000	90000
	1.4 Additional Modelling studies											
6	1.4.1	Annual modelling and seasonal assessment	For flood forecasting in support of annual Emergency planning meeting	Action Plan	MWDI with consultant	Reports and output from modelling	5000	5000	5000	5000	5000	25000

6	1.4.2	Refinement of flood zone mapping policy	As model is updated, flood zone policy will need to be refined/developed	Action Plan	partners	studies in support of geomorphological assessments, sedimentation studies. Annual modelling assessment for flood season risk management			20000			20000
9	1.4.3	Geomorphological baseline assessment/modelling	Essential for further detailed assessment of the options	Action Plan			175000					175000
9	1.4.4	Sedimentation options assessment	Including development of sedimentation mitigation measures	Action Plan				120000				120000
9	1.4.5	Geomorphological modelling	For detailed options feasibility assessments	Action Plan				20000	20000	20000	20000	80000
10	1.4.6	Adaptation of the Shire Model to provide a distributed (grid-based) hydrological model for the full Shire basin to be developed for real-time use (e.g. based on a threshold-frequency approach)		Action Plan			20000					20000
10	1.4.7	A flood estimation study to develop statistical and unit hydrograph methods for the Shire Basin and associated guidelines, including flash flood guidance indicators for use both off-line and in real-time use		Action Plan				200000				200000
10	1.4.8	An investigation of the accuracy of the current Meteosat and TRMM satellite precipitation products and other sources (e.g. the weather radar at Beira in Mozambique, and the planned Global Precipitation Mission outputs), with recommendations on communications and other improvements needed for real-time operation		Action Plan					100000			100000
	1.5 Modelling for feasibility studies											
12	1.5.1	Reconstruction of Chiromo Bridge		JICA				80000				80000
12	1.5.2	Diversion of Ruu into Elephant Marshes		JICA					80000			80000
12	1.5.3	Detailed design of Structural measures		Action Plan/SRBMP-I	MWDI with consultant partners	Reports and output from modelling studies in support of options feasibility and design studies.	100000	100000	100000	100000	100000	500000
12	1.5.4	Detailed design of catchment management (non-structural) options		Action Plan			20000	20000	10,000			50000
12	1.5.5	Modelling study to support FFEWS		Action Plan/SRBMP-I			50000					50000
	1.6 Training and Support											
3	1.6.1	HD Model Support and Training	Train up at least 1 modeller from each organisation.	Action Plan/SRBMP-I	MWDI, DCCMS, DNRDM with consultant partners	Structured training and support programme delivered over the 5-year period. 2-3 Malawians university trained in flood risk assessment and management methods by year 5	50000	50000	50000	50000	307000	507000
			Total Modelling Cost									5346000

Table 1-5: Action Plan - Flood Forecasting and Early Warning Systems

High level Goals	Theme	Intervention	Detail of Action	Funding	Responsible Agency and Implementing Partners	Evaluation/Indicators of success	Y1 (US\$)	Y2 (US\$)	Y3 (US\$)	Y4 (US\$)	Y5 (US\$)	Total (US\$)
Enhancing Flood Preparedness and response through development of a flood forecasting and early warning system for the Shire basin	2. Flood Forecasting and Early Warning Systems											
	2.1 Terms of Reference for Consultancy Services for FFEWS design and operation											
1	2.1.1	Inception Phase		Action Plan/SRBMP-I	MWDI with consultant partners	Fully developed ToR for FFEWS, procurement of contractor and completion of the design of the FFEWS. Support and training for FFEWS practitioners in new FFEWS system	58800					58800
	2.1.2	Design, specs and tender docs (1 or more contracts)		Action Plan/SRBMP-I			103500					103500
	2.1.3	Data interpretation and procedures for issue of flood warnings		Action Plan/SRBMP-I			148000					148000
	2.1.4	Acceptance testing of ICT equipment		Action Plan/SRBMP-I			31000					31000
	2.1.5	Dissemination of warnings to districts and communities		Action Plan / UNDP / ECRP (DFID, Ireland & Norway)SRBMP-I			17500	14500				32000
	2.1.6	Establishment of Community based flood warning systems		Action Plan / UNDP / ECRP (DFID, Ireland & Norway)			100000	11500	11500	11500	11500	146000
	2.1.7	Establishment of Lower Ruoi/Lower Shire Scheme		Action Plan/SRBMP-I			121000	11500	11500	11500	11500	167000
	2.1.8	Training of District personnel		Action Plan/UNDP				35500				35500
	2.1.9	Training of MWDI staff		Action Plan/SRBMP-I				35500				35500
	2.1.10	Consultant Support for FFEWS		Action Plan/SRBMP-I			9000	7000	5000	3500	2000	26500
	2.1.11	Flood Forecasting (support, assistance, procurement advice, reviews and reports)		Action Plan/SRBMP-I			11500	83000	11500	11500	11500	129000
	2.1.12	Institutional Support for FFEWS (management of data and warning procedure; training)		Action Plan/ UNDP/SRBMP-I			0	0	0	0	0	0
2	2.2 River level gauges - Provision of 15 new/upgraded river level gauges											
	2.2.1	Purchase, ship telemetry & other equipment		Action Plan / AfDB/NWDP SRBMP-I, SADC HYCOS / ECRP (DFID, Ireland & Norway)	MWDI, and consultant partners	Procured and installed river level gauge and telemetry equipment at 15 river gauging sites. Support, maintenance and training provided over the 5-year period	197000	98000				295000
	2.2.2	Install telemetry & other equipment at MWDI sites - to include raingauges at some sites		Action Plan / AfDB/NWDP SRBMP-I, SADC HYCOS / ECRP (DFID, Ireland & Norway)			44500	22000				66500
	2.2.3	Civil works		Action Plan / AfDB/NWDP SRBMP-I, SADC HYCOS / ECRP (DFID, Ireland & Norway)			45400	22700				68100
	2.2.4	River gauging equipment		Action Plan / AfDB/NWDP SRBMP-I, SADC HYCOS / ECRP (DFID, Ireland & Norway)				200000				200000

	2.2.5	Include raingauges at up to 10 river gauge sites		Action Plan / AfDB/NWDP SRBMP-I, SADC HYCOS / ECRP (DFID, Ireland & Norway)			11000					11000
	2.2.6	Supplier support, maintenance and training (5 years)		Action Plan / AfDB/NWDP SRBMP-I, SADC HYCOS / ECRP (DFID, Ireland & Norway)			22800	22800	22800	22800	22800	114000
2	2.3 Raingauges - Provision of 15 new raingauges											
	2.3.1	Purchase, ship telemetry & other equipment		Action Plan /SRBMP-I/ DCCMS plans (climate risk)	DCCMS, MWDI, consultant partners, and contracting partners	Procured and installed raingauges (15). Support, maintenance and training provided over the 5-year period	175900	88000				263900
	2.3.2	Install telemetry & other equipment at DCCMS sites		Action Plan / SRBMP-I/DCCMS plans (climate risk)			44000	22000				66000
	2.3.3	Civil works		Action Plan /SRBMP-I/ DCCMS plans (climate risk)			4000	2000				6000
	2.3.4	Supplier support, maintenance and training (5 years)		Action Plan /SRBMP-I/ DCCMS plans (climate risk)			0	26500	26500	26500	26500	106000
3	2.4 Telecoms Fees - Annual telecommunications fees for 5 years - telemetry and warning dissemination											
	2.4.1	SMS and call charges from 20 sites		Action Plan / AfDB/NWDP SRBMP-I, SADC HYCOS	MWDI, DCCMS	SMS charges cost over 5-year period	1400	1400	1400	1400	1400	7000
	2.4.2	Toll free numbers		Action Plan			3300	3300	3300	3300	3300	16500
3	2.5 Equip MWDI Ops room											
	2.5.1	Meteosat ground station purchase ship install etc.	Purchase ship install etc.	Action Plan / possibly SADC HYCOS	DCCMS, MWDI, DNRDM and consultant partners	Procured and installed telemetry software, hardware and Ops room equipment. Fully equipped and functioning Ops room after 5 years	18000	0	2000	2000	2000	24000
	2.5.2	Ops room telemetry software	Supply, set up, training	Action Plan / AfDB/NWDP SRBMP-I, SADC HYCOS			28000					28000
	2.5.3	Ops room IT hardware	Supply and support	Action Plan /UNDP/ AfDB/NWDP SRBMP-I, SADC HYCOS			14000					14000
	2.5.4	Provide backup for GWAN at MWDI	Broadband rental	Action Plan			13200	13200	13200	13200	13200	66000
	2.5.5	Support package - IT equipment		Action Plan / UNDP / SRBMP-I				1100	1100	1100	1100	4400
	2.5.6	Alarm dissemination	Software, hardware and support	Action Plan/SRBMP-I			22000	1700	1700	1700	1700	28800
	2.5.7	Operations centre equipment and security		Action Plan/SRBMP-I			36500	73500				110000
	2.5.8	Additional equipment for DCCMS Forecasting Centre	Telemetry software, support and training	Action Plan/SRBMP-I/UNDP			17000					17000
	2.5.9	Ops room IT hardware	Supply and support	Action Plan/SRBMP-I			6500	600	600	600	600	8900
	2.5.10	Upgrade DNRDM Ops. Room for flood warning related equipment		Action Plan/ UNDP				27000				27000
3	2.6 Radios											
	2.6.1	HF Radio	Connect 5 districts, DNRDM, MWDI & Met (supply, support and training)	Action Plan	MWDI, DCCMS, DNRDM with consultant partners	Procured and installed radio equipment in 5 district and DNRDM,	116500	11000	11000	11000	11000	160500

	2.6.2	VHF Radio	Reliable back up voice communications	Action Plan		MWDI and DCCMS. Support and training provided in the used of equipment	40500	17000	18500	20000	21000	117000
4	2.7 Warning Dissemination											
	2.7.1	Cell broadcast	Feasibility study and 3 month trial	Action Plan/ UNDP(2.3,2.7 &2.8)/ECRP(DFID, Irish Aid & Norway) / UNDP/SRBMP-I	MWDI	Procurement and provision of cell phones and other equipment to communities. Website designed and implemented	148000					148000
	2.7.2	Website	Feasibility study and implementation	Action Plan / WB SDI, SRBMP-I, AfDB/NWDP				11000	22000	22000	22000	77000
	2.7.3	Cell phones	For reception of auto generated alarms and cell broadcast including chargers	Action Plan/ECRP (DFID, Irish Aid & Norway) / UNDP			15500					15500
	2.7.4	Community-based scheme equipment	Megaphones, bicycles, flags, posters, personal safety equipment etc	Action Plan /ECRP (DFID, Irish Aid & Norway)/UNDP/ possibly SRBMP-I			89500	89500	89500	89500	89500	447500
5	2.8 Flood Forecasting											
	2.8.1		Forecasting System and models	Action Plan / SRBMP-I Operational DSS	MWDI, DCCMS	Forecasting system and models procured, installed and fully operational at the end of 5-year period		73500	127000	95000	65000	360500
6	2.9 National Flood Warning Initiatives											
	2.9.1	National Flood Warning Investment Strategy	Development of national strategy and in particular recommendations on how the Shire Basin FFEWS will be funded beyond Year 5 of the Action Plan	Action Plan/UNDP/SRBMP-I	MWDI, DNRDM, DCCMS and consulting partners	Fully developed national flood warning investment strategy by end of year 1	102000					102000
			Total FFEWS Costs									3888900

Table 1-6: Action Plan - Institutional Development and Capacity Building

High level Goals	Theme	Intervention	Detail of Action	Funding	Responsible Agency and Implementing Partners	Evaluation/Indicators of success	Y1 (US\$)	Y2 (US\$)	Y3 (US\$)	Y4 (US\$)	Y5 (US\$)	Total (US\$)
Building Capacity for Flood Risk management in Malawi - Institutional Strengthening	3. Institutional Development and Capacity Building											
	3.1 MWDI											
2	3.1.1	MWDI to be involved - install, commission, manage and maintain improved river gauging - manual and telemetered	Staff should be involved in the procurement, installation, commissioning, management and maintenance of new and rehabilitated river gauges	Action Plan / AfDB/NWDP SRBMP-I, SADC HYCOS	MWDI	MWDI staff recruited and fully employed in management of the Action Plan and the activities included in developing and installing the FFEWS equipment			3000			3000
1	3.1.2	Provide a staff member to be the modeller	Staff will be trained on the job under elements of the Action Plan	Action Plan			12000	12000	12000	12000	12000	60000
3	3.1.3	Provision of a programme manager / administrator and support services	MOIAWD will appoint a programme manager and associated support staff	Action Plan			20000	20000	20000	20000	20000	100000
3	3.1.4	Project Management support and Training for MWDI	External expertise will be used to develop and deliver a programme of training to emerging MOIAWD staff including the programme manager	Action Plan/SRBMP-I			23000	18000	18000	18000	18000	95000
3	3.1.5	Provision of MWDI Sub programme manager		Action Plan			15000	15000	15000	15000	15000	75000
	3.2DCCMS											
2	3.2.1	Met to be involved - install, commission, manage and maintain rain gauges.	Staff should be involved in the procurement, installation, commissioning, management and maintenance of new and rehabilitated rain gauges	Action Plan / DCCMS plans (climate risk)	DCCMS	DCCMS staff recruited and fully employed in the activities included in developing and installing the FFEWS equipment			3000			3000
3	3.2.2	Met data digitisation and entry	Allowance to enable junior met staff member to digitise and enter all relevant data (including water) to model database	Action Plan/SRBMP-I								0
	3.3 Weather Forecasting											
7	3.3.1	MET services improve accuracy of 5 day, 10 day, long term and intense storm forecasts	MET services improve accuracy of forecast	Action Plan/UNDP?/SRBMP-I	DCCMS	Improved accuracy of met forecast by 10% in each year over the 5-year period (measured by number of forecasts that are within 70% expected values???)	14000					14000
7	3.3.2	Met Services to share data from Mozambique	Exchange visit to initiate data sharing and follow up	WMO? / Action plan			10,000	10,000	10,000	10,000	10,000	50000
	3.4 DNRDM											
6	3.4.1	Ensure warnings are followed up and delivered	Develop protocol with external assistance	Action Plan/UNDP (PSD 5.1)	DNRDM	Established and implemented protocols for warning dissemination and follow up, flood event coordination procedures, emergency procedures and for the development of contingency plans. Training of regional and national partners in new protocols	25,000	25,000	25,000	25,000	25,000	125000
5	3.4.2	DNRDM - support districts during flood events	Vehicle with communications equipment which can act as operations centre deployed to flooded area(s)	Action Plan			170000					170000
4	3.4.3	DNRDM - Coordination procedures	Develop protocol / standard procedures with external assistance	Action Plan								0
6	3.4.4	Training by DNRDM of all stakeholders in warning systems	Training of trainers and district level training courses	Action Plan/UNDP PSD 1.4 , 2.7 and 2.8			35000	12000	12000	12000	12000	83000
5	3.4.5	DNRDM training	Training at regional, national , international partner level on response under a "State of Disaster" with external assistance	Action Plan/UNDP PSD 5.1 and 3.1				13500	3500	3500	3500	24000

5	3.4.6	DNRDM Finance Procedures	Develop protocol / standard procedures for emergency procedures with external assistance	Action Plan/UNDP PSD 5.1 and 3.1								90000
5	3.4.7	DNRDM Operating Procedures	Development of standard operating procedures and plans for the event of state of disaster due to flooding with external assistance	Action Plan/UNDP PSD 5.1 , 3.1 and 3.4)								90000
5	3.4.8	DNRDM Communications	Connectivity and synchronisation between local national and international agencies with external assistance	Action Plan/UNDP PSD 5.1, 3.1 and 3.3)								50000
5	3.4.9	DNRDM - procedures for Recovery	Development of contingency plan for recovery efforts with external assistance and training	Action Plan/UNDP PSD 5.1 and 3.1								90000
6	3.4.10	DNRDM/NGOs - Community awareness training	NGO support to update existing community schemes, new schemes trained	Action Plan			5000	5000	5000	5000	5000	25000
	3.5 Monitoring and Evaluation											
7	3.5.1	Monitoring so that improvements and adjustment can be made to ensure its progress and success	External expertise will be used to make an annual technical audit of progress and propose modifications and actions	Action Plan/SRBMP-I	External audit (consultant) partner	Results of annual audits	23000	13000	13000	13000	13000	75000
	3.6 Guidelines											
7	3.6.1	Flood defence design guidelines	Local or possibly external expert to develop revised design manuals	Action Plan/SRBMP-I	MWDI with consultant partners	Flood defence guidelines document produced in year 1	20000					20000
8	3.6.2	Training course on use of guidelines	Expert will train target users on the guidelines	Action Plan/SRBMP-I			20000					20000
			Total Institutional Costs									1262000

Table 1-7: Action Plan - Structural Interventions

High level Goals	Theme	Intervention	Detail of Action	Funding	Responsible Agency and Implementing Partners	Evaluation/Indicators of success	Y1 (US\$)	Y2 (US\$)	Y3 (US\$)	Y4 (US\$)	Y5 (US\$)	Total (US\$)
Reducing flood risk and building resilience in Malawi	4. Structural Interventions											
	4.1 Flood Defences - Gabion protected bunds											
1	4.1.1	Nsanje	Construction of defence according to detailed design	Action Plan/ECRP (DFID, Ireland & Norway)/SRBMP-I	MWDI with contractor partners	Flood defences built to appropriate standards		380000	455000			835000
2	4.1.2	Chikwawa	Construction of defence according to detailed design	Action Plan/ECRP (DFID, Ireland & Norway)/SRBMP-I				670000	365000	91000		1126000
2	4.1.3	Allow for increased bund length (Nsanje & Chikwawa)	Construction of defence according to detailed design	Action Plan/ECRP (DFID, Ireland & Norway)/SRBMP-I				500000	400000	45000		945000
3	4.1.4	Allow for other Districts	Construction of defence according to detailed design	Action Plan/ECRP (DFID, Ireland & Norway)					200000	200000	200000	600000
	4.2 Flood Defences - Sand Bag protected bunds											
1	4.2.1	Nsanje	Construction of defence according to detailed design	Action Plan/ECRP (DFID, Ireland & Norway)/SRBMP-I	MWDI with contractor partners	Flood defences built to appropriate standards		107000	36000	4000	65000	212000
2	4.2.2	Chikwawa	Construction of defence according to detailed design	Action Plan/ECRP (DFID, Ireland & Norway)/SRBMP-I				44000	8000	7000	31000	90000
2	4.2.3	Allow for increased bund length (Nsanje & Chikwawa)	Construction of defence according to detailed design	Action Plan/ECRP (DFID, Ireland & Norway)/SRBMP-I				75000	20000	5000	50000	150000
3	4.2.4	Allow for other Districts	Construction of defence according to detailed design	Action Plan/ECRP (DFID, Ireland & Norway)					200000	200000	200000	600000
	4.3 Catchment Improvement											
4	4.3.1	Mwanza Catchment (allowance - awaits further assessment)	Implementation of catchment management plan	Action Plan/ECRP (DFID, Ireland & Norway)	MWDI with MoA, Forestry Department and external partners	Catchment Improvement Plan completed and implemented by end of 5-year period			200000			200000
5	4.3.2	Ruo Catchment (allowance - awaits further assessment)	Implementation of catchment management plan	Action Plan/ECRP (DFID, Ireland & Norway)					200000			200000
5	4.3.3	Other Catchments (allowance - awaits further assessment)	Implementation of catchment management plan	Action Plan/ECRP (DFID, Ireland & Norway)						1000000		1000000
	4.4 Food/Grain Stores											
2	4.4.1	Nsanje	Construction of district flood/grain stores	Action Plan/ECRP (DFID, Ireland & Norway)/SRBMP-I	MWDI with contractor partners	Number of grain stores built and fully functioning in each district	20000	30000	30000	30000	30000	140000
2	4.4.2	Chikwawa	Construction of district flood/grain stores	Action Plan/ECRP (DFID, Ireland & Norway)/SRBMP-I			20000	30000	40000	40000	40000	170000
6	4.4.3	Allow for other Districts	Construction of district flood/grain stores	Action Plan/ECRP (DFID, Ireland & Norway)				40000	40000	40000	40000	160000
	4.5 Dredging											
	4.5.1	Maintenance of waterways at critical culverts and bridges	Annual dredging	Action Plan	Min of Transport		20000	20000	20000	20000	20000	100000

	4.6 Flood Proofing of Buildings											
	4.6.1	Study of benefits of flood proofing of existing buildings to act as flood shelters	Local or external expert to assess practicalities, cost and benefits	Action Plan	MWDI			20000				20000
			Total Structural Interventions Costs									6548000

The total cost of all proposed interventions is presented in Table 1-8 below:

Table 1-8: Action Plan Summary Costs

	Estimated Cost (US\$)
HD Modelling	5,346,000
Flood Forecasting and Early Warning	3,888,900
Institutional Development and Capacity Building	1,262,000
Structural Interventions	6,548,000
Sub Total	17,044,900
All Contingency (15%)	2,556,735
TOTAL ACTION PLAN COST	19,601,635

Cost estimates for each activity or intervention have included a contingency allowance – with the allowance applied being generally appropriate to the level of confidence of estimation of cost for that activity. The development of proposals for the Plan has been undertaken in the context of a US\$20million budget assigned by the World Bank. With this budget in mind, we have applied an overall contingency allowance of 15% to the Action Plan – to provide some protection to the possibilities of overspend. The Action Plan tables include a column to show Funding. Here, whilst World Bank has committed to funding the Action Plan up to the “budget” of US\$20million, it is apparent that other donors are currently funding or are proposing to fund projects that overlap with some of the activities shown in the Plan. Accordingly, we have indicated where we are aware of such overlaps or of the intention of other donor funded projects to implement these interventions. At this stage, this cannot be viewed as a definitive interpretation and it is intended that the proposed Action Plan is discussed with donors so that the overall funding arrangements can be clarified.

1.5. Prioritisation

An important objective of the Action Plan has been to establish a prioritised list of interventions – so that the most urgent requirements are clearly identified for the earliest implementation.

The prioritisation of activities listed under each of the four headings in the Action Plan has been undertaken following the consideration of various criteria. These criteria are different for the different Action Plan headings, as shown below:

- HD Modelling Framework
 - Importance to the Action Plan objectives
 - Cost
- Flood Forecasting and Early Warning (FFEWS)
 - Importance to the Action Plan objectives
 - DEC and main stakeholder comment
 - Cost
- Institutional Development and Capacity Building
 - Importance to the Action Plan objectives
 - DEC and main stakeholder comment

- Cost
- Structural Interventions
 - Technical impact/effectiveness
 - Practicality of implementation
 - DEC Comment
 - Economic viability
 - Cost
 - Environmental Impact

Initially, consideration had been given to the establishment and use of a decision matrix to guide prioritisation but this was rejected as inappropriate for this project. Rather, the use of the criteria shown has, in the main, been based on judgement, which in turn has been based on an understanding of the prevailing situation in the Shire Basin and on information provided by stakeholders.

Thus, the prioritisation of the HD Modelling Framework activities has been largely based on the TOR requirements to establish, maintain, improve and operate a hydraulic model.

Similarly, the priority of activities for FFEWS has been primarily influenced by the requirement to provide a terms of reference for the design and implementation of a new/improved flood forecasting and early warning system. Other important considerations that influenced the priority are the comments and feedback from the communities and stakeholders and cost.

Determination of the priority of Institutional activities has taken account of the required urgency for support and training for the major institutions – to enable realisation of the objectives of the Action Plan – having regard also to information gathered from the stakeholders and activity cost.

For structural interventions, the technical effectiveness – in minimising flood impact – and the practicalities of construction have been considered. As explained earlier, large capital intensive projects have not been recommended for inclusion in the Action Plan due to difficulties in demonstrating their viability at this stage and because their cost is likely to exceed the currently available budget. Thus cost effectiveness, based on benefit/cost ratio, and the ranking of priorities by the DEC has been taken account of. Future assessments will take further account of environmental issues.

Thus the most critical villages in Chikwawa and Nsanje have been identified and structural interventions to mitigate the flood impact to these villages have been assessed largely on a technical viability and cost effective basis. Further assessment will be required to confirm priorities once improved topographical data has been obtained, enabling re-assessment using the HD model, improved cost estimates and a re-evaluation of benefit–cost ratios. Similarly, improved topographical data will enable assessment and prioritisation of measures to minimise impact to villages in Mulanje, Mwanza, Thyolo and Blantyre districts.

It should be emphasised that the priorities – the ranking to show those activities for the earliest implementation – will need to be reviewed periodically. As studies are progressed and as further data is generated, it is expected that priorities will change and it is important that those responsible for the management of the Action Plan recognise the need for review and regular updating.

The concept of prioritisation is crucial to the success of the Action Plan. This concept will ensure that the most critical activities are undertaken first – that mitigation is provided first to the most severely impacted communities – that resources are deployed most efficiently and that funding is directed to where it is most needed. It is important that donors and stakeholders “buy-in” to this concept at the outset and that their commitment is maintained as assessments are improved and prioritisations are confirmed.

1.6. Quick Wins

Consideration has been given to those activities or interventions that can be undertaken quickly – requiring minimal administration, in some cases lesser cost, and the potential for providing early benefits.

The proposed “Quick Wins” have been highlighted in Tables 1-4 to 1-7 and are listed below:

Table 1-9: Quick Win Options

Option Index	Options title
1.2.1	Purchase HD Modelling Software
1.2.3	Purchase HD Modelling Hardware
1.2.5	Update the HD Model for LiDAR and sub-daily data
1.3.1	Undertake key topographic surveys for extension of HD Model
1.3.1	Assistance with digitising paper copies of sub-daily rainfall and flow data
1.6.1	Provide a MWDI staff member to be the Modeller
3.1.2	HD Model Support and Training
3.5.1	Establishment of a Monitoring and Evaluation (M&E) Procedure
3.6.1	Initial visit(s) to Mozambique to facilitate data exchange
3.6.2	Study/draft new guidelines for design of flood defences

The procurement of the above “Quick Wins” may need separate procurement arrangements. These are discussed in Section 1.7.

1.7. Procurement Plan

The options proposed for inclusion in the Action Plan have been assembled into packages appropriate for procurement – having regard to their scope, cost, complexity and proposed timing.

The proposed packages are listed in Table 1-10 below.

Table 1-10: Proposed packaging of activities for the Action Plan

	Package	Description
A	HD Model Services	Model improvement and support; further option assessments; geomorphological studies and modelling
B	HD Model Software	Supply and maintenance of model software
C	HD Model Hardware	Supply of hardware for use with the HD Model
D	Assistance with Data Provision	Digitising of rainfall and flow data and improvement of data collection
E	Topographic Surveys	Topo and hydrographic surveys of tributaries and

		critical reaches of the Shire
F	Consultancy Services for FFEWS	Design, training and support for new FFEWS including management and maintenance of installations
G	Rain and Flow Gauges	Supply, installation and maintenance of rainfall and flow gauges
H	Assistance to DNRDM and MWDI	Technical and management support to DNRDM and MWDI
J	IT and Communication Equipment	Supply, installation and maintenance of IT and Communication equipment
K	Community Based FFEWS schemes	Installation, commissioning and maintenance
L	Structural Interventions	Installation and maintenance including design participation

Indicative scheduling of these packages over the five years of the Action Plan is shown in Figure 1-2.

Due to the extended programme for the Action Plan – over five years - and, in some cases, the varied geographical location, it is expected that some of the packages will be divided into sub-packages:

Package E, Topographic Surveys – it is intended that these surveys will be undertaken by local survey companies as discrete packages of works, appropriate to their size and geographical location.

Package H, Assistance to DNRDM and MWDI – this package contains a miscellany of assistance services that will require different skills and will be undertaken at different times during the Action Plan period.

Package K, Community Based FFEWS Schemes – the Action Plan provides for implementation of up to 10 community based schemes over a five year period. It is envisaged that the first of these schemes will be implemented in Year 2 by an NGO/Contractor consortium. Implementation of successive schemes by the same consortium will need consideration – it is likely that continuation by the same consortium would be based on their performance on the initial scheme.

Package L, Structural Interventions – these interventions will include construction of flood defence bunds, food stores, catchment improvements and dredging. The variety of skills required, the varied geographical location and the intermittent timing of construction will require these works to be let as separate sub-packages. Also, it is anticipated that communities will participate in many of these schemes – perhaps under the supervision of MWDI or an NGO – and any tendering and contract award procedures for these schemes will have to take account of such arrangements.

Also, the Quick Wins listed in Table 1-9 are likely to be procured by means of separate contract packages – via sub-packages as suggested in Table 1-11 below.

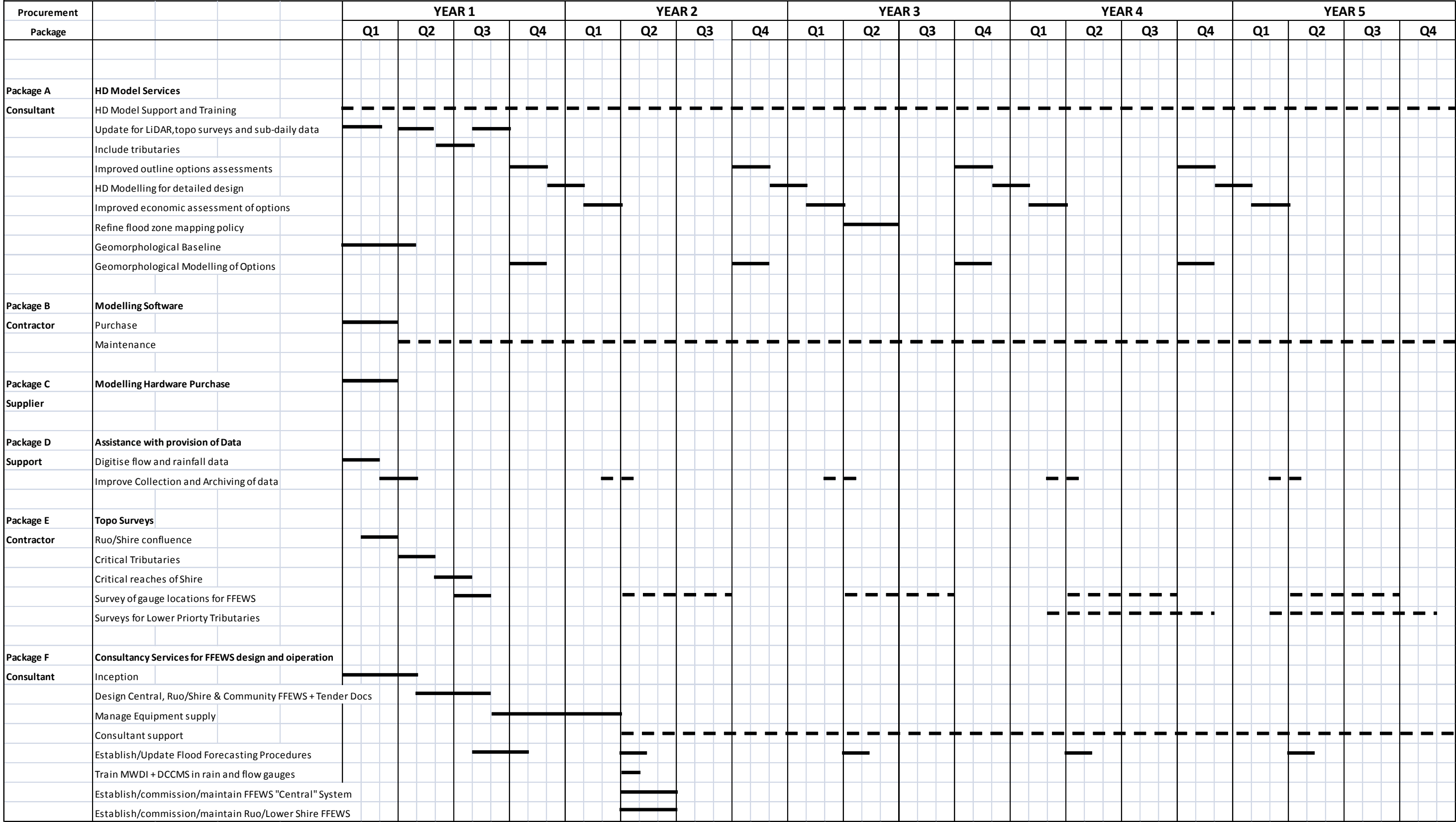
Table 1-11: Proposed Arrangements for Procurement of Quick Wins

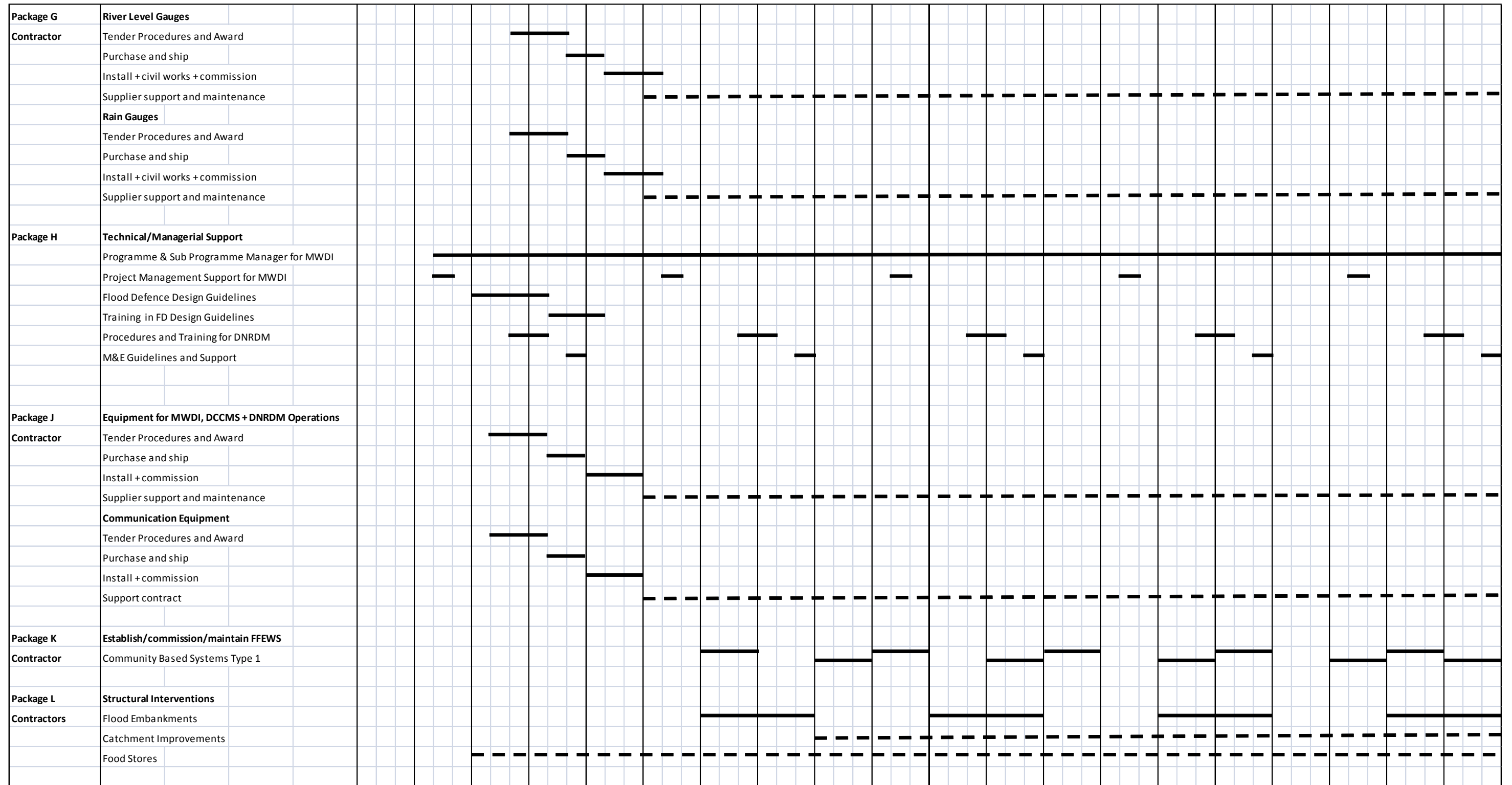
Package	Sub Package	Option
Package A	Sub Package A1	Update the HD Model for LiDAR and sub-daily data
	Sub Package A2	HD Model Support and Training
Package B	Complete	Provide HD Model Software
Package C	Complete	Provide HD Model Hardware

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Package D	Complete	Assistance with Data Provision
Package E	Sub Package E1	Topo Surveys to enable initial extension of the HD Model
Package H	Sub Package H1	Provision of MWDI staff as Modeller
	Sub Package H2	Establishment of M&E procedures
	Sub Package H3	Flood Defence Design Guidelines

Figure 1-2: Action Plan Programme





1.8. Future Plan

Beyond the five years of the Action Plan, there will be a requirement for the continuation of key activities.

A summary of those activities that are likely to require external funding beyond Year 5 is given in Table 1-12 below.

Table 1-12: Activities beyond Action Plan requiring External Funding

Theme	Options
HD Model Services	Topo Surveys to extend the coverage of the Model
	Modelling for Feasibility Studies
	HD Model Support
FFEWS	Provision of rain gauges (extend coverage_
	Provision of flow gauges
	Community based scheme equipment
	Improvements to Flood Forecasting
	Support to National Flood Warning Investment Strategy
Institutional Development	Support to MWDI – Project Management and Modeller
	Training and support to DNRDM
Structural Interventions	Flood defence embankments – all districts
	Catchment improvements – critical tributaries
	Food stores – all districts
	Assess requirement for flood proofing of churches and schools to act as community shelters
	Off-channel and in-channel storage – feasibility studies

The requirement and programming of these activities will be integrated with the Shire Basin Management Organisation which is expected to assume responsibility for water management in the Shire Valley in the years to come.